Technology-enhanced surgical education: attitudes and perceptions of the endoscopic surgery community in Turkey

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ABSTRACT

The education programme of surgery has unique problems. In this study, first, a literature review is conducted to cover the studies found in the literature reporting on the problems of surgical education. Additionally, a survey study is conducted with 31 participants, who are either currently enrolled in endoscopic surgery education programmes in Turkey or are experts in the field. Supportively semistructured individual interviews are also conducted with five participants. These data are collected to better understand the instructional methods being used, their problems and the participants' preferred methods to be used. Additionally, the participants' attitudes are also investigated regarding the use of new technologies to enhance the current education programmes. The results indicate that, in Turkey, surgical education programmes are still mostly offered in traditional ways while other educational methods are used in an extremely limited manner. In general, the authors emphasise that more research needs to be conducted to better understand the characteristics of the medical students and develop standards for surgical education programmes, educational tools specific for related surgical domains and guidelines for the curriculum integration. The results of this study aimed to guide the instructional system designers for the endoscopic surgery education programmes.

INTRODUCTION

In general, medical education programmes face serious challenges. For instance, a study conducted with medical students about their experiences with, and actual and desired levels of, competence for nine procedural skills shows that participants rate themselves as being unable to perform these procedural skills without assistance.[1] What's more, and there is a variation on the participants' current competency levels which indicates the need of improving technical competency among graduating students.[1] Since it is important that surgeons acquire the necessary skills to the best prior to their first surgery,[2] this issue becomes even more important. In this respect, barriers to effective teaching are analysed and students' and faculties' attitudes as one of such barriers in implementing new educational approaches in curricula.[3] Endoscopic surgery is performed by the reflection of camera-captured views of the patient's operational field through a special camera and light source named endoscope. As a result, these operations require some additional skills to be developed. In other words, endoscopic surgery education programmes have some additional challenges.

Hence before providing alternative solutions for these programmes, understanding the educators' and trainees' attitudes towards these new approaches is a critical matter. Accordingly, in this study, first the general problems of surgery education are reviewed from the available literature. Afterwards, to better understand the attitudes towards the new technologies for enhancing conventional surgery education, a survey is carried out with 31 surgeons and interview sessions are conducted with 5 of them who have either currently enrolled in or are experts in surgery education programmes.

TRADITIONAL SURGICAL EDUCATION PROGRAMMES

Candidate surgeons have to develop a lot of skills and perform exhaustive practice. During surgery, they need to make quick and accurate decisions and operate in an environment in which they are in constant interaction with the assistants and nurses. In this way, teamwork becomes a required trait as well.[4] Traditional surgery education is provided in the operating theatre with the supervision of an experienced surgeon using the 'see one-do one-teach one' method.[5 6] However, studies report that this approach brings about certain problems. For instance, the education offered in operation rooms is bound by working hours, thus rendering it as not an ideal method.[2] Additionally, teaching basic surgical skills on human patients or cadavers raises ethical issues.[2] Another problem is providing an environment to acquire the necessary skills for managing complicated situations, which is not always possible during such programmes since they prove to be too risky.

As another alternative, using a cadaver is a costly procedure because of limited repetitive training alternatives. Additionally, finding an available expert surgeon is not always possible, which increases the cost of this education even further. For instance, studies report the importance of repetition in medical education and the problem of medical curricula being often employed in compressed ways and over limited time frames.[7] They also report the importance of visualisation skills, active engagement and involvement in medical education which are not adequately provided in traditional education environments.[7] Similarly, due to the reason that each student learns at a different rate, the

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traditional approach does not work consistently with everyone.[3] Hence, the problems of surgical education during the practical phase are considerably high, and people enrolled in these programmes need to study hard to improve the required skills. Studies indicate that if a surgeon does not possess the necessary skills very risky situations can be faced.[8 9] It is only possible to acquire these skills by personalised and exhaustive education programmes. The best way to overcome such issues is reported to provide corresponding education programmes via simulators which is also observed by an experienced surgeon.[10]

TECHNOLOGY-ENHANCED SURGICAL EDUCATION

Several simulation environments developed for surgical education[11 12] and contemporary solutions are offered.[13] These environments have a lot of advantages since they are cheaper and zone-independent while also providing more time for drill and practice as they can be highly repetitive, modified for different situations and can provide feedback about the performance of the trainee.[14] Three-dimensional realisations of the data and interactive functionality provide a feeling as if the user is in a real environment.[15] Hence, this creates an opportunity to develop an educational programme without using animal or human cadavers.[16] Additionally, by the help of these technologies a real-time and objective technical skill assessment is also possible.[17–20] In these environments, students can learn from their mistakes without the possibility of hurting anybody.[21] Aside from this, education can be further enriched by exposing students to different 'what if' scenarios and the environments can be used in order to teach preoperation planning and detection of the portion location under operation.[22] Today there are several studies on simulation-based educational technologies for the surgical education programmes.[6 23–28] Studies report that simulation has great potential to fulfil several unmet needs in healthcare innovation.[29]

However, there are very limited examples of such training programmes that are integrated with the surgical training curriculum. Hence, before developing solutions, the main obstacles for better developing and integrating the technology enhanced surgical education programmes are needed to be understood. Accordingly, this study aims to better understand the current problems of endoscopic surgery education programmes and to understand the surgeons' attitudes and perceptions on these new technologies.

METHOD

For the present research, a survey is conducted with 31 participants either providing this education or enrolled in these education programmes. A questionnaire specific for this purpose was prepared, and prior to administration, the items were used tested with 10 individuals. According to the feedbacks, the items used in the questionnaire were modified and reorganised. Additionally, a one-on-one interview session is organised with five of the participants in the form of semistructured sessions each taking up to 20–30 min. The interviews were voice recorded and transcribed and corresponding data were analysed to better understand the situation based on the research questions of this study.

The participants of the study are from six different institutions. One participant was formally educated in an institution outside of Turkey for her doctorate degree. Others were graduated from Turkish universities as follows: Ankara University, Hacettepe University, Gazi University, Süleyman Demirel University and Dışkapı Education and Research Hospital. The participants' ages are between 27 and 52 years, with an average of 36 years, SD=7.

Table 1 Participants

Academic positions of the participants		
Position	**n**	**Female**
Full professors	4	1
Associated professors	3	0
Specialists	9	0
Assistant professors	4	1
Research assistants	11	1
Total	31	3
Endoscopic surgery education		
Years	**n**	**Female**
6	4	1
5	6	1
4	2	0
3	2	0
2	3	0
1	9	1
Total	26	3

Three of the participants were females and the other 28 were males (table 1).

Twenty-six participants have answered their years of endoscopic surgery education question. Accordingly, four participants have taken 6 years of endoscopic surgery education while nine participants have taken 1 year of endoscopic surgery education.

RESULTS

The results of this study are analysed under four main categories with regard to Turkey. A summary of the results appears as follows.

PROBLEMS OF SURGICAL EDUCATION

The participants were asked to list the problems they faced during their education. As this question was an open-ended one, in order to better understand the participants' general view on this item, all responses are analysed one by one by the same researcher and coded according to their main concerns. Among the responses, one participant declared that he did not face any problem. Two participants declared that even though the endoscopic surgery is being performed in their hospitals the education is insufficient; however, they did not report any reason for this. Hence, these responses were not included in the analyses. As a result it is seen that they all make comments on one of the following issues: general problems, problems of traditional methods, limited number of cases, limited number of models, close to reality, operational tools and limited number of experts (table 2). Accordingly, five participants pointed out to some problems indicating that the current educational environment is

Table 2 Endoscopic surgery education problems

	n
General problems	5
Problems of traditional methods	5
Limited number of cases	5
Limited number of models close to reality	4
Operational tools	3
Limited number of experts	2
Total	24

Table 3 Preferred and being used methods for surgical education

	Being used		Preferred	
Instructional method	**n**	**%**	**n**	**%**
C: cadaver	–	–	26	84
VR: virtual reality	–	–	20	65
V: video	20	65	12	39
TB: training box	4	13	11	35
Traditional	27	87	10	32
A: animals	–	–	–	–

not their ideal one. For example, according to one participant, 'In our hospital, endoscopic surgery operations do take place; however the training for this purpose is inadequate.' On top of that, others stated that, during surgery, it is not always possible to define any limits. During these operations, there is no depth perception, and the training requires patience. Among the participants who responded to this question, five reported that the conventional education based on observations in the operating theatre is very limited and problematic as well. For example, one participant said, 'As research assistants we are involved as observers in the endoscopic surgery operations. Rarely do we have a chance to assist the surgeon. Given the fact that this type of surgery operations is likely to become more popular in the near future, the related education should cover the usage of endoscope, and we should gain the required skills for this.'

Similarly, another participant pointed to the importance of learning by doing, stating that the alternatives for this purpose are limited. When the participants' responses about this issue are analysed, one can observe that expert surgeons tend to not allow endoscope to be used by the research assistants during a surgery operation on real patients in the operating theatre. On the other hand, research assistants are more than willing to get a chance at additional practice and apart from only observing. For example, one participant declared, 'In our institution, this type of operation is performed by a professor. However, he never gives the endoscope to his assistants.'

Similarly, another participant reported that during the traditional education programmes assistants need to be given enough time to practice with the endoscope, adding that there are also problems with limited number of operating rooms. Five participants stated that there are also a limited number of cases for such operations which also limits the possibility for observations. Four participants said that there are no models to be used during this education. Three participants also reported that they could not access any operational tools and, as such, are unable to use them for practice.

METHODS APPLIED IN SURGICAL EDUCATION

In order to understand the educational methods being used in surgery education in Turkey, we have listed the possible alternatives and asked the participants to select the ones that they are currently using throughout their training. Among these, the traditional method is defined as the one that is in the literature, known as 'see one-do one-teach one' method[5 6] provided in the operating theatre on a real patient. The other methods are listed as learning through watching operational videos, practising with human cadaver dissections, practising on training boxes, practising on virtual reality environments and practising on animal cadaver dissections. The participants were free to select more than one alternative provided in the questionnaire. Each instructional method that is selected by the participant is coded as '1', and if the method is not selected it is coded as '0'. Most of the participants (87%) are involved in (enrolled in or graduated from) the traditional training programmes provided in the operating theatre (table 3).

The second method that is widely used for this education is through watching videos (20 participants). No participant indicated the usage of virtual reality, cadaver or animal dissection during their education. Only a limited number of participants (four participants) stated that they are using training boxes (figure 1).

During the interviews considering this question, one participant stated, 'I mostly learn through videos that I receive from my professor or the ones found on the Internet. I watch several videos which help me a lot to understand the procedure. I don't have much other chance to be involved in the operating room, because these kinds of operations are rarely performed in our hospital.'

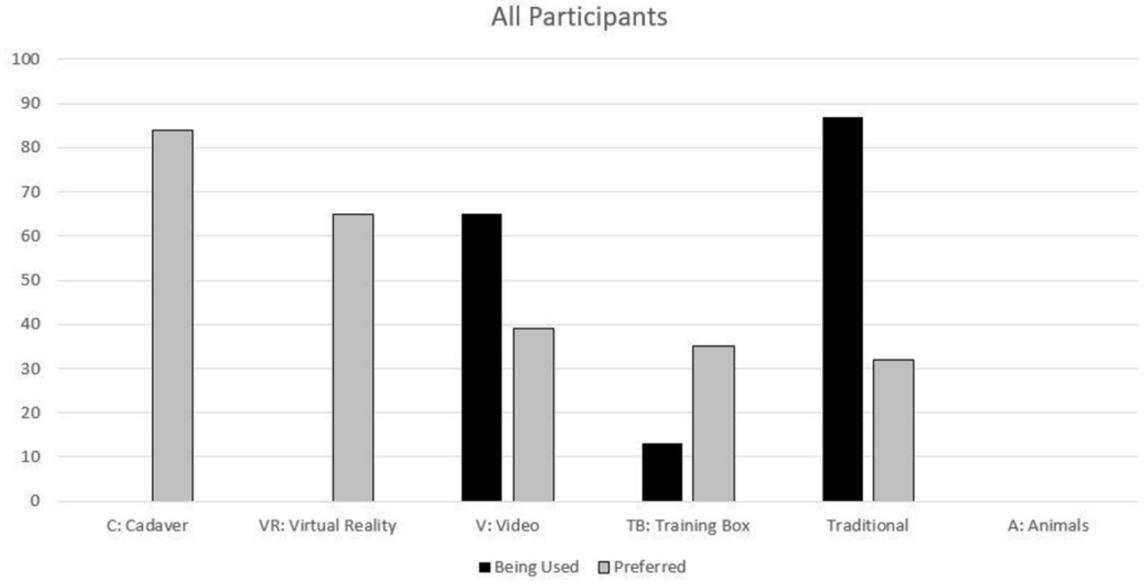

Figure 1 Preferred and being used methods of learning.

As a conclusion, the most widely used educational method for endoscopic surgery in Turkey seems to be the traditional one, see one-do one-teach one, provided in the operating theatre on real patients (87%). As a learning aid, the trainees usually (65%) watch videos of real operations to better understand the process and review the details and alternatives of the operation.

PREFERRED METHODS TO BE USED IN ENDOSCOPIC SURGERY

The participants were enquired about their method(s) for endoscopic surgery education. Accordingly, most of the participants prefer to be trained using human cadaver dissections (84%) (table 3). Following this, virtual reality environments are their second preferred way of training alternative (65%). Training through watching videos (39%) and using training boxes (35%) comes next, with no participant opting for animals. However, very limited number of participants (32%) declared their preference being the traditional method of educational environments. During the interviews, one participant said, 'I prefer to practice by making mistakes and seeing the consequences of these mistakes. Currently, there is no such chance. I believe that an unlimited practice environment would be best for this type of education. After this, at some point, training in the operating room is a must.' According to another response, 'I know some simulators providing practice with endoscope. But I haven't had a chance to use such systems. I wish we could have access to such environments.' From these results, it can be concluded that the most preferred way of education is the cadaver dissections along with virtual reality environments.

In general, videos as a method of learning being used (65%) were higher than that of the preferred one (39%). The mean preference for the method of learning on box training (35%) was also higher than that of the being used one (12%). Finally, the results indicated that the mean being used method of learning on traditional methods (87%) was higher than that of the preferred one (32%). While professors were more likely to prefer the traditional methods, this ratio is lower for the other groups (table 4 and figure 2).

The mean for the currently being used method of learning through watching videos is much higher for the research assistants (82%) than that of the professors (25%). None of them use the human cadaver dissections; however, especially the research assistants and associated professors are willing to reach a training through this method (100%). This ratio is also high for the assistant professors (75%) and specialists (89%). Interestingly, professors' preferences on cadaver dissections are lower (25%).

Results show that currently participants do not have an opportunity to have training through virtual reality (figure 2). However, they are willing to reach such learning environments. Especially the specialists' preferences on virtual reality-based learning environments are higher (100%) than that of the research assistants (63%), assistant professors (50%) and professors (50%).

ATTITUDES TOWARDS VIRTUAL REALITY IN ENDOSCOPIC SURGERY

Table 5 lays out the questions asked in order to understand the participants' attitudes towards the use of virtual reality environments to support the traditional endoscopic surgery education. The participants were to select one of the alternatives from 'strongly disagree', 'disagree', 'no idea', 'agree' and 'strongly agree'. The choice of strongly agree is evaluated as 5 and strongly disagree as 1. The mean scores appear in the table.

According to these results, the participants mostly have positive attitudes towards the use of virtual reality environments in endoscopic surgery education. During the interviews they also stated that, if they had a chance, they would willingly use virtual reality environments to improve their skills on endoscopic surgery.

DISCUSSION AND CONCLUSION

The studies found in the literature show that there are serious problems in the field of endoscopic surgery education. According to the results of this study, similar problems are being faced during endoscopic surgery education in Turkey as well. Due to certain reasons, the expert surgeons generally do not wish to teach their assistants in the operating room and during actual surgery. Apart from this, trainees also seek drill and practice environments to improve their skills, complaining that they cannot do so merely by observing actions. Although there have been several studies attempting to provide alternative solutions for these educational environments, there is still an urgent and persistent need to better support endoscopic surgery education and integrate these technologies to the current educational environments. These studies further show that the research conducted on surgery education is very limited with respect to technical skills assessment.[30] According to the results of this study, the participants of the survey are mostly willing to practice on human cadaver dissection (84%) and virtual reality environments (65%). However, currently they do not have a chance for training in these environments. Hence, there is a gap between their preferred and current method of learning for these methods (cadaver dissection and virtual reality). According to

Table 4 Preferred method of learning according to academic positions

		Full professors		Associated professors		Specialists		Assistant professors		research assistants	
Instructional method		n	%	n	%	n	%	n	%	n	%
Traditional	Being used	3	75	2	67	9	100	3	75	10	91
	Preferred	2	50	1	33	3	33	1	25	3	27
Video	Being used	1	25	2	67	6	67	2	50	9	82
	Preferred	–	--	1	33	5	56	1	25	5	45
Cadaver	Being used	–	–	–	–	–	–	–	–	–	–
	Preferred	1	25	3	100	8	89	3	75	11	100
Training box	Being used	–	–	–	–	2	22	1	25	1	9
	Preferred	2	50	–	–	2	22	1	25	6	55
Virtual reality	Being used	–	–	–	–	–	–	–	–	–	–
	Preferred	2	50	–	–	9	100	2	50	7	63

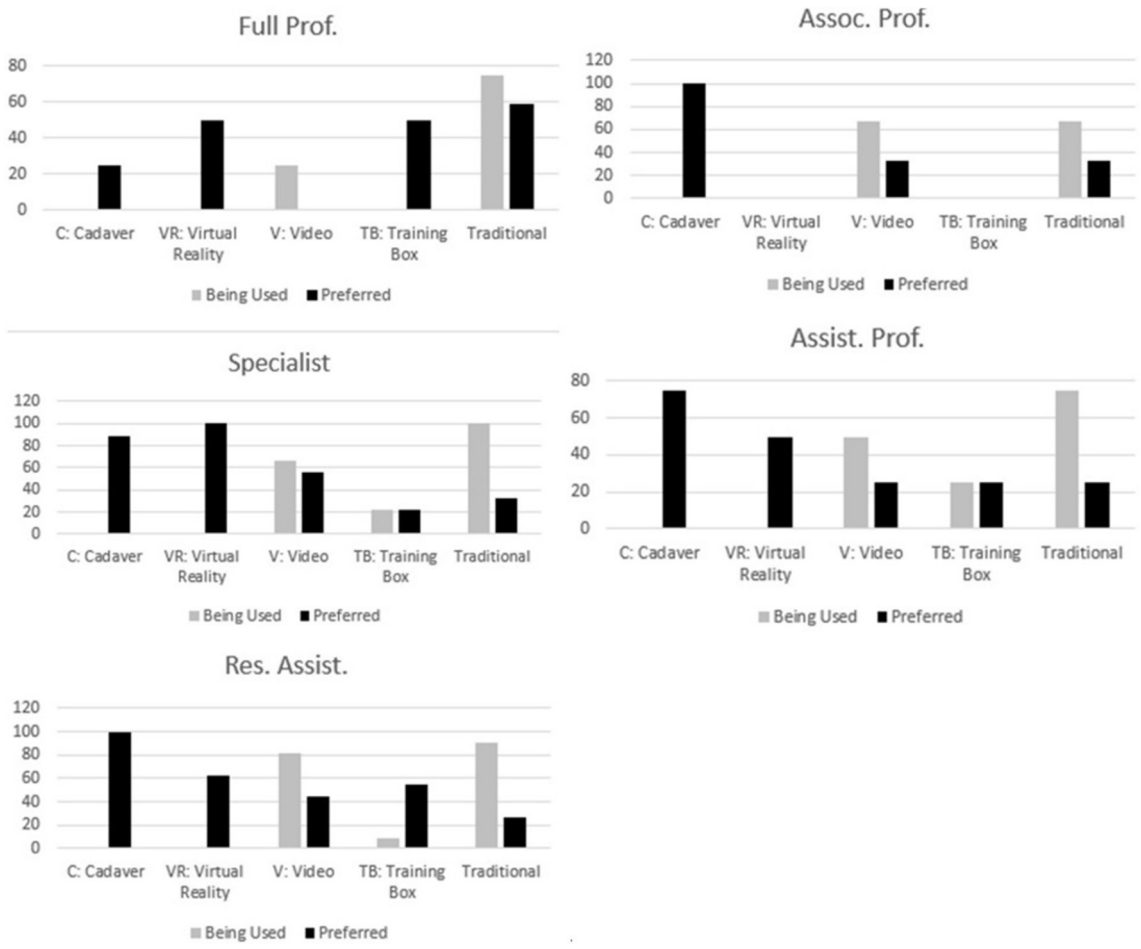

Figure 2 Preferred and being used methods of learning according to academic positions.

the results of this study, preferences of full professors as teaching modality for cadaver dissections (25%) are lower than that of the research assistants (100%), specialists (89%) and associated professors (100%), indicating that participants in different skill levels have different preferences on method of learning.

In general, they learn through traditional education in the operating room and by watching videos. Once asked about their preferred method, preference of videos (39%) is lower compared with the virtual reality (65%) and cadaver (84%). Similarly, mean for traditional education drops from 87% (current method of education) to 32% (preferred method), indicating that educators and trainees are willing to use alternative educational methods, such as cadaver and virtual reality. Studies found in the literature show that the available technologies to support endoscopic surgery education programmes can potentially improve the current conditions. Specifically, today's virtual reality and augmented reality technologies can be used to create realistic operation environments, especially for endoscopic surgery education programmes.

According to the results, it can be said that there is an urgent need to incorporate these technologies into the curriculum of endoscopic surgery education programmes. It is reported that the field of medical education requires an adaptation to change early enough to influence outcomes; however, this change to enhance medical education is a hard process.[31] According to Andersen (p. 1), 'Simulation applications that facilitate the assessment and learning of expert intraoperative judgment should include a consensus-derived outline based on CTA of the operative steps and potential points of risk for each surgical procedure; the ability to detect the situational awareness of the performer and the options considered to avoid error at critical steps; an assessment (scoring) of options considered or attempted; immediate evaluation feedback to inform improved performance; and a program of deliberate practice in which progressively more challenging scenarios can be introduced, based on the trainee's demonstrated skills.'[32]

There are several other studies indicating that the features of technologies being developed for surgical education, as well as the supported pedagogical approaches, are important to successfully integrate these technologies into traditional education environments. Examples include curriculum sequencing, clear learning needs, clear goals and well-defined learning objectives,

Table 5 Participants' attitudes towards the use of virtual reality in endoscopic surgery education

Item	Score
Training using virtual reality simulators should be integrated into the curriculum	4.58
Using virtual reality simulators improves basic skills	4.53
My motivation to use virtual reality simulators is high	4.37
Using virtual reality simulators can be beneficial for me	4.32
Before training in operating rooms, virtual reality simulators should be used in a satisfactory manner	4.05
I would like to have more time for training	3.95
Using virtual reality simulators is necessary for me	3.79

assessment methods and tools, the standards being supported for documentation, development, assessment and teaching on these tools, appropriate levels of difficulty, reliable measures and reliable feedback mechanisms and advancement to the next tasks.[3 32 33] However, there are several dimensions to be considered for better integration of these technologies for the surgical education programmes which can be summarised as below.

Characteristics of medical students: Earlier studies show that there are significant differences between medical students and non-medical students considering their self-efficacy, intrinsic value and self-regulation characteristics.[34] Students of secondary medical school achieve statistically significant higher results on the agreeableness scale compared with general education secondary schools[35] and score higher on agreeableness[36] where it may emerge from temperamental self-regulative systems[37] as agreeableness describes warm and friendly personality. Besides, this study also reports a difference in the preferences of participants having different academic degrees (different skill levels) (see table 4). Hence, the researchers of the field of instructional technology need to consider these characteristics of medical students before providing technology-enriched educational environments for them.

Availability of the appropriate standards for surgical education programmes, in general, and endoscopic surgery education programmes, in specific: During the interview sessions of this study, three of the participants have mentioned that there is no objective and standardised method for assessing the endoscopic surgery skills which is very critical to better evaluate and guide the trainee. They have reported that all assessments are based on individual and subjective evaluations. In the literature also there are very limited studies to define such standards for surgical skill-level definitions or ways to define the characteristics of educational tools developed for these programmes. Another standardisation study is also required to support developing strategies for individualised instructional programmes through these tools. Another point is that there is no standardised way of classification for these tools to addressing education-related problems in the field. Hence, a standardised approach is required for the educators to guide them to better adapt these technologies according to the specific requirements of their educational programmes.

Availability of appropriate educational tools specifically developed for surgical education programmes: Despite the presence of several tools developed for improving the surgical education programmes, their availability for many institutions is very limited. In the case of Turkey, for instance, such implementations are rare. The authors believe that the cost factor of these systems, limited functionality and adaptability features of these systems are the main barriers to a wider scope of access.

Availability of guidelines for curriculum development: Tools and strategies that are developed to implement presimulation preparation[38–40] specific to the virtual reality content and context may help the educators to better develop integrated curriculum. Additionally, the virtual reality simulation tools need to come with some solutions to better implement classroom applications such as flipped learning to help the educators for implementing an effective strategy for the pedagogical shift in preparing students for didactic and clinical experiences[41] and developing integrated curriculum alternatives.

As a conclusion, technology-enhanced surgical education programmes, in general, and neurosurgical education programmes, in specific, require quick, systematic and standardised approaches to better integrate educational technologies in their programmes and to improve their outcomes. With this in mind, researchers in the field of educational technology and experts in endoscopic surgery education programmes can come together to address such issues. Additionally, as Seagull also reports, the human factors for improving simulation activities need to be addressed in this area.[42] As endoscopic surgery requires some specific skills to be developed, the human factor describing the characteristics of medical students may become even more critical.

LIMITATIONS AND FUTURE WORK

This study is conducted with very limited number of women. It has been reported that in Turkey only 5.4% of the neurosurgeons are women,[43] which is 9.8% of the participants in this study. Because of this limitation, results were not analysed according to the gender differences. Additionally, the number of surgeons in this specific field is also very limited. Accordingly, the number of participants was also limited which is a general limitation for this field. As a summary, further research is required on the following concepts:

- which standardised measures can be applied to assess the surgical skill levels objectively
- which characteristics need to be supported by educational tools developed for surgical education
- criteria for classifying surgical education tools and methods for better addressing education-related problems
- standardised measurement tools that aim to provide feedback on the progress of the trainee and guidance for further improvements during educational programmes
- guidelines for developing appropriate curricula in endoscopic surgery education.

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